stayed to form the front of the buttress. On the inner side of these planks was placed a template of the gage, having fixed in it wooden pegs of proper size, and so spaced as to form holes for the expansion nuts of the holding on bolts. The template itself moulded the recess for the brass scale. On the inner side of the heavy planks, and on the downstream side of the template, the right-hand side as one reads it, wood figures sawn from ½-inch stuff, were tacked to form indented figures in the concrete face opposite the foot marks. The space to be occupied by the buttress was then boxed in as the work of filling progressed, with short horizontal boards, extending from the edges of the vertical planks to the face of the wall and flaring with angles of 45°. Portland cement concrete of about the character used in the best cement walks and curbs, constituted the filling. Next to the wall the mix was of fine gravel, and strong mortar was freely used in flushing into the joints and interstices of the wall, and in forming the bond with its face. The work was carried up in comparatively thin sections to give opportunity for the setting of the cement, and two weeks were allowed for hardening after the completion of the filling, before the mould was removed. The brass scale was then bolted in, and the surfaces were smoothly troweled with neat cement.

The weight of this structure is about 22,000 pounds, and the holding surface, that is, the area of the bond between buttress and wall, approximately 16,000 square inches, so that even with indifferent construction the work would be reasonably secure. With good construction and the addition of anchor bolts, its permanence can not be doubted, and may be held to depend only upon the stability of the supporting wall.

THE CLIMATE OF ST. LAWRENCE ISLAND.

By Mr. A. J. HENRY, Chief of Division.

St. Lawrence, the largest island in Bering Sea, is situated in latitude 64° N., longitude 170° W. It is about 400 miles north of the well-known Pribilof group and about 200 miles south of the Arctic Circle. The nearest land, the Siberian coast, is a little less than 100 miles distant.

The Presbyterian Board of Home Missions built a schoolhouse in the Eskimo village of Chib-u-Chak (Gambell) on the extreme northwest corner of the island in 1891, but it was impossible to secure a teacher until some years later. The first teacher secured by the board, Mr. V. C. Gambell, kindly consented to make meteorological observations while on the island. He began observing in October, 1894, and continued until September, 1897. Mr. W. F. Doty succeeded him as observer in November, 1898, observing regularly until he left the island in June, 1899.

Mr. Gambell was supplied by the Weather Bureau with standard self-registering thermometers and a rain gage. He did not succeed in measuring the precipitation, but we are indebted to him for a valuable series of temperature observations, which we have summarized in the accompanying tables. Mr. Gambell's record has been supplemented by the observations made for eight months by Mr. Doty. The latter did not have self-registering maximum and minimum thermometers, but it is evident from the observed extremes he has furnished that he kept close watch on the thermometer. In transmitting his observations to the Central Office, Mr. Doty writes as follows:

I have the honor to transmit herewith some meteorological observations made by me at Gambell, St. Lawrence Island, extending from November 1, 1898, through to July 11, 1899. The thermometer used was a Fahrenheit, and I fancy was quite accurate. It was not provided with an automatic register. Observations were made three times a day. I did not have a barometer, a rain or snow gage, or any instrument to gage the velocity of the wind. I guessed at the force of the wind and found that one of the whaling captains confirmed my estimate of the strength of a gale in the late spring, and believe that, as a rule, I did not overestimate. The maximum and minimum thermometers were out of order and so could not be used. It was quite impossible to estimate the depth of snowfall, as the wind blows the snow into the air from the ground, while it is snowing and the snow is piled into great drifts in places and carried off elsewhere. A question mark has been placed in the column for the record of snowfall to designate that snow fell on that day.

Before taking observations daily I observed the thermometer from time to time during October and noticed a very gradual lowering of the temperature during the month. I fancy that this steadiness during the latter part of September and October was remarkable in contrast with the change from day to day in the winter. The spring greatly resembled the fall in this respect, save that of course the temperature rose.

* * * * * * *

Temperatures observed at Gambell, St. Lawrence Island, Alaska (latitude, 63° 34′ N.; longitude, 171° 45′ W.)

MONTHLY MEAN TEMPERATURES (Max. + Min.) ÷ 2.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1894										27.5	19.3	5.9
1895	4.2	−8.0	0.6	14.8	28.8	37.6	43.6	42.8	38.3	27.3	21.9	1.3
1896	2.8	−12.8	1.4	16.4	22.4	34.7	42.7	41.7	36.4	30.0	28.5	6.5
1897	5.0	3.4	−3.4	12.5	29.4	37.9	45.5	46.8	38.6			
1898											23.8	7.3
1899	6.3	6.8	14.5	14.9	31.5	36.5						
Means	4.6	−2.6	3.3	14.6	28.0	36.7	43.9	43.6	37.8	28.3	23.4	5.2

MAXIMUM TEMPERATURES.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1894										42	34	33
1895	28	14	32	37	45	48	59	59	50	42	36	30
1896	29	25	35	38	35	45	54	51	48	39	35	30
1897	31	33	33	34	44	62	58	57	50			
1898											34*	31
1899	30	35	35	42	38	46						
Extremes	31	35	35	42	45	62	59	59	50	42	36	33

MINIMUM TEMPERATURES.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1894										15	5	−18
1895	−21	−31	−23	−18	12	27	34	34	23	18	0	−25
1896	−18	−25	−29	−6	3	26	30	32	21	16	16	−17
1897	−15	−22	−31	−9	17	26	33	36	29			
1898											8*	−19
1899	−20	−10	−16	0	18	30						
Extremes	−21	−31	−31	−18	3	26	30	32	21	15	0	−25

* Observed readings November, 1898, to June, 1899.

Miscellaneous data for Gambell, St. Lawrence Island, Alaska.

Weather and wind.	1898.		1899.						
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
Clear days	1	8	11	12	8	4	3	0	1
Partly cloudy days	4	6	11	8	3	5	7	4	4
Cloudy and foggy days	25	17	9	8	20	21	21	26	6
Prevailing winds	ne.	ne.	ne.	e.	ne.	ne.	e.	sw.	sw.
Number of times observed from—									
North	2	10	17	8	3	6	11	2	
North-northeast	4								
Northeast	34	34	39	15	29	47	21	3	5
East-northeast	4			1	1	1			
East	23	22	1	29	2	9	20	3	1
East-southeast	1								
Southeast	2	10	4	7	17	7	4		1
South-southeast					3	1	1		
South	4	2	21	5	8	5	3	3	6
South-southwest							6	2	1
Southwest	5	2			16	2	3	39	11
West-southwest								3	
West				2	1	5		27	4
West-northwest									
Northwest	7		3		1		3	1	
North-northwest	1								

NOTE.—Out of a possible 664 observations the wind was observed to be northeast 227 times, giving an approximate percentage of 34; east wind, 119 times, approximate per cent, 18; this leaves 308 possibilities for all the other 14 directions, or 48 per cent. In the table the data for

July covers 11 days only. The scale of wind force is as follows: 6 = gale, or 45 miles per hour; 7 = strong gale or 60 miles per hour, and 8 = violent gale, or 75 miles per hour. Fog has been regarded as 10 on the scale of clouds. Observe that there was a vast deal of cloudy or foggy weather in March, April, May, June, and July. In June there was not a clear day. The cold in winter is keenly felt because of the high winds and by reason of the moisture in the air—there are open places in the ice.

THE SLUGGISHNESS OF THERMOMETERS.

By C. F. MARVIN, Professor of Meteorology.

When a thermometer is placed in a medium, the temperature of which is not the same as that of the thermometer, an interchange of heat immediately sets in and presently the thermometer and the medium take on the same temperature. A sluggish thermometer will be slow to arrive at the temperature of the medium, whereas a sensitive thermometer will take this temperature much more quickly. The foregoing brings out the significance of the words sluggish and sensitive in the present connection, and, in what follows, methods will be described by which these qualities or properties of thermometers may be measured, and the results applied in estimating the accuracy of the observations obtained by the use of a given instrument to measure the temperature of a medium, especially when this temperature changes more or less rapidly.

It is obvious that if the temperature of the medium changes quickly, and more or less continuously, there will be a "lag" in the indications of the thermometer, depending upon its sluggishness and the rapidity with which the temperature continues to change; that is, the temperature indicated by the thermometer at a given moment of time will be a temperature experienced by the medium several moments before. In other words, the temperature of the thermometer will be a certain amount higher or lower than that of the medium, and the discrepancy will persist as long as the temperature of the medium continues to change in the same sense. This lag is especially marked when more or less sluggish thermometers and thermographs are used in the measurement and registration of the temperature of the air, since the latter has but a small capacity of carrying heat to or away from a thermometer bulb. Whenever it is practicable to do so, therefore, the air whose temperature is desired, is passed in a strong current over the bulb of the thermometer, or the thermometer itself is whirled through the air at a comparatively rapid rate; both accomplish the object of bringing the thermometer quickly to the temperature of the air, or, if the air temperature is changing, of reducing the error due to sluggishness to the minimum.

The effects of sluggishness are illustrated perhaps more strikingly in the accompanying diagram, Fig. 1. First let us suppose a thermometer to be quickly plunged into cold air of a constant temperature, represented on the diagram by the line *T T*. Owing to its sluggishness the thermometer does not instantly take on the temperature of the air, but reaches it gradually after a series of changes, such as represented by the curve t_1 t_2, for example. If, however, the temperature of the air changes steadily, the thermometer either does not acquire the temperature at all, or assumes it momentarily only to lag behind afterward, as shown in the diagram, where d and d' indicate the errors in the indications of the thermometer due to sluggishness, when the temperature changes uniformly. The error is larger the more sluggish the thermometer and the more rapid the rate of change in air temperature.

Effects of ventilation.—When the circulation of the air about the bulb of a thermometer is so rapid that the surface of the bulb is maintained at sensibly the same temperature as that of the air, the thermometer will then exhibit its maximum sensitiveness, and no increase in the rapidity of circulation will further affect the sensitiveness. The sluggishness in such cases has to do wholly with the flow of heat in the interior of the bulb and the movement of the mercury in the narrow bore of the tube. When, however, the temperature of the exterior surface of the bulb is not maintained at the same point as that of the medium as a whole, then we may consider that portions of the medium stagnate, as it were, about the thermometer and prevent the free escape of heat from the bulb, or its access thereto, as the case may be. The apparent sluggishness under these circumstances may be very considerable, and differs according to the degree of circulation. The degree of ventilation required to secure the maximum sensitiveness is hardly known, but for air it is doubtless very considerable, whereas for thermometers plunged in water, for example, it is probable that, under moderate agitation, the extreme surface of the bulb is sensibly at the same temperature as that of the liquid.

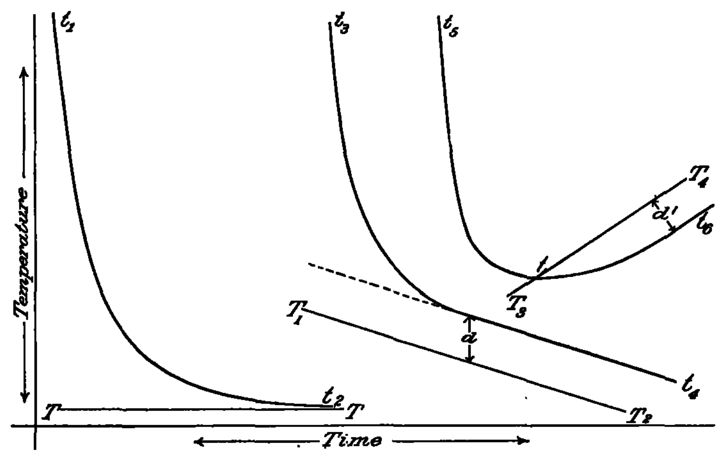

FIG. 1.—Curves illustrating sluggishness of thermometers.

t_1 t_2 temperature curve of a warm thermometer placed in a colder medium whose temperature remains constant.

t_3 t_4 temperature curve for a warm thermometer in a colder medium whose temperature steadily falls. The temperature of the thermometer continues d units higher than that of the medium.

t_5 t_6 temperature curve for a warm thermometer in a colder medium whose temperature steadtly rises. At t the temperature of the thermometer and the medium are momentarily the same and the curve is horizontal, but owing to its sluggishness the thermometer presently thereafter indicates a temperature d' units too low.

According to the accepted theory of the flow of heat under these circumstances, it is assumed that the rate at which the thermometer will change its temperature at any given instant is proportional to the difference between its temperature at the moment and that of the ambient medium. In order to express this in the form of an equation—

Let U = the temperature of the air at any moment.

Let u = the corresponding temperature indicated by the thermometer.

Then, the momentary rate at which the thermometer changes its indications will be

$$\text{Rate} = r = k\,(U - u) = \frac{du}{dt}$$

In which k is a coefficient of sensitiveness to be determined by experiment. The greater the value of k the more sensitive the thermometer.

This equation is one of the most convenient for computing the value of k from experiments, especially when the thermometer traces its own record, as in the case of thermographs recording on sheets moving at a comparatively rapid rate.

When thermographs are sent up into the free air on balloons, kites, etc., which generally pass more or less quickly through strata of air having successively different tempera-